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From water footprint to climate change adaptation: Capacity development with teenagers to save water

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ABSTRACT

This article presents a bottom-up approach which attempts to link the Water Footprint (WF) concept with climate change adaptation and capacity development. The approach was developed and tested in cooperation with a partner school in Austria aiming to provide a starting point for WF assessment and formulate an improvement response. The pupils reduced their WF by 9%, and became change agents. The approach assists young people to develop self-efficacy by discovering the connection between their individual actions at local level and aspects of climate change adaptation at global level. It provides a tool to increase this understanding and contribute to the adaptation of distant impacts of climate change and reduce vulnerability.

1. Introduction

The water sector will be significantly affected by climate change (IPCC, 2013). In particular, the trend of ever increasing water demand has a significant impact on the quantity and quality of water available at local and global scales (IPCC, 2014a; United Nations, 2015b; UNWWAP, 2015). As emphasised by the UNs Sustainable Development Goal "Clean Water" (United Nations, 2015b), an urgent need to adapt freshwater management and policies to these changes has been identified (European Environmental Agency, 2015; Haida et al., 2017). Complementing mitigation efforts, many global and national climate change policies have adopted climate change adaptation strategies (European Commission, 2013, IPCC, 2014a, 2014b) to prevent or minimise possible negative effects and to enhance opportunities. This is ever more important also in light of the ambitious targets set during COP21 in Paris (United Nations, 2015a). Enhancing capacity building has been agreed on as one of many actions to strengthen the abilities of countries to respond to climate change impacts. Together with Education for Sustainable Development (UNESCO, 2017) these two toolkits are essential for achieving the COP21 targets, in particular awareness building regarding trans-regional responsibility is vital (Haida, 2016). Developing and implementing successful adaptation measures in freshwater management should involve local stakeholders, integrate numerous policy areas (e.g. regional development and water management) and apply low-regret measures and bottom-up processes. The water footprint (WF) concept helps to reduce global water consumption and thus provides a tool to adapt to the impacts climate change has on water by communicating, assessing and improving the WF (Chapagain et al., 2006).

According to Hoekstra et al. (2011) the WF is an indicator of fresh water use which includes both the direct and the indirect water use of a consumer or a product, also defined as the direct WF and the indirect WF, respectively. This can be calculated for a specific product, process, person or region and generally consists of the three components: blue, green and grey WF (c.f. Hoekstra et al., 2011). The green water footprint refers to the total precipitation or soil moisture held in the unsaturated and is available to plants, while the blue water footprint is an indicator of the amount of fresh surface or groundwater consumed in producing goods and services. The grey water footprint is a measure of pollution and is expressed as the volume of water required to assimilate the pollutant load to meet ambient water quality standards.

Direct WF accounts for the direct consumption and pollution of

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fresh water caused by activities such as domestic water use for a person, operational water use in factories or businesses, and the use of internal national water resources for a country. The indirect WF is based on the concept of virtual water (Allan, 2003) and thus does not only account for the amount of water physically contained in a product, but also includes the amount of water, which is used during the entire production process. By trading water intensive products, a country or a region creates "virtual water flows". These can be instrumental in relieving the pressure on the internal water resources of a region, whilst creating dependencies on external water resources and vice versa (Chapagain and Hoekstra, 2008).

WF assessments have been suggested to be an effective means of raising awareness of global water challenges among stakeholders outside the water policy sector (Chapagain and Tickner, 2012). Although efficient water use is essential for sustainable water use, a focus must also be made on the equitable and fair distribution of this limited resource. Therefore, there is an urgent need to evaluate the sustainability of current consumption patterns in the light of a growing world population and the limited freshwater resources (Hoekstra, 2013). Under climate change conditions, fresh water availability will decrease and become more unevenly distributed across the globe (IPCC, 2014a), whilst socioeconomic developments and population growth are predicted to increase the demand for water (UNWWAP, 2015; Wang et al., 2016). For example, under a moderate to low population growth scenario from the UN, the fresh water availability in 2050 will be 835–1045 m^3/year/capita. This, however, is exceeded by current water demand, with a global average WF of 1385 m^3/year/capita, ranging between 1250–2850 m^3/year/capita in industrialized countries and 550–3800 m^3/year/capita in developing countries (Hoekstra and Mekonnen, 2012).

The production of agricultural products is responsible for 70% of the total blue water withdrawals from aquifers, lakes and rivers (UNWWAP, 2015). Furthermore, adding the green and grey WF components to the blue WF for food production, more than 90% of the global average WF is related to food consumption (Hoekstra and Mekonnen, 2012). Focusing on the food sector there are various levels and leverage points to reduce the WF and make it more sustainable:

- policy level: increasing the volume of food which is traded through efficient trade relationships (Dalin et al., 2012) by encouraging an export of agricultural goods produced in water rich and water efficient regions to water scarce and less efficient regions considering other limited resources can result in a smaller usage of water per produced amount of crop and can save ~6% of water used in agriculture (Chapagain et al., 2006).
- producer level: increasing water productivity (i.e. the inverse of the virtual water content per product) of agricultural products and industrial processes (Vanham and Bidoglio, 2013),
- consumer level: changing peoples' diet, for example reducing consumption of animal products (especially meat) has a large impact on the WF, as app. 50% of cereal production (in the EU) is used as fodder for animals (Vanham et al., 2013),
- all levels: reducing food losses (producer level) and food wastes (consumer level) along the entire food supply chain (Vanham and Bidoglio, 2013; Vanham et al., 2015); increasing awareness concerning the relation between a person's behaviour and the WF, and the supply and demonstration of methods to reduce the WF.

This demonstrates that good water governance requires a sharing of responsibility between consumers, governments, businesses and investors, with each playing different roles (Hoekstra, 2013). Consumers, however, are the biggest drivers and offer the greatest leverage for adaptation, as they are the key for the three remaining actors to change.

To date, the WF concept has mainly been used to calculate the WF of a product, a company or nation, illustrating virtual water flows, connecting these with climate change scenarios and deriving potential water saving strategies (Hoekstra and Chapagain, 2007; Chapagain and Hoekstra, 2008; Mekonnen and Hoekstra, 2011; Orlowsky et al., 2014). However, little work has been done to actually implement water saving strategies by applying the WF at the consumer level. To do so, a suitable approach is needed, which conducts bottom-up climate change adaptation by linking climate change with the WF. To achieve this, capacity development provides a suitable framework to encourage stakeholders to adapt and reduce their WF to sustainable limits. According to UNDP (2008, p. 4) capacity development is defined as "the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time".

In this context, a successful WF adaptation approach needs to be sustainable, participative, long-term oriented, should have a multiplier effect and the outcomes need to be evaluated. Based on these requirements, this article presents an innovative bottom-up approach to improve the personal WF. By linking the WF concept with climate change adaptation and capacity development this novel approach provides a tool to empower individuals within their capabilities to contribute to the adaptation to the impacts of climate change. The objectives of this approach are to i) create awareness among young people regarding their water consumption habits and the consequences, ii) relate the complex issue of global water management to personal consumption habits and thereby facilitate the development of self-efficacy among young people, iii) link global climate change impacts with local water consumption, and iv) empower young people to use their capabilities to take action in adapting to climate change. Thereby, furthering the UNs Sustainable Development Goal "Climat Action" (United Nations, 2015b), this approach assists in responding to and preparing for climate change impacts on fresh water on the global scale and thus provides a valuable tool. The aim of this article is to describe this approach, followed by its practical implementation and evaluation in a regional case study.

2. Water footprint adaptation approach

2.1. Theoretical background and concepts relevant for the approach

Although the development of the water footprint approach is based on various theoretical backgrounds, there are three particular theoretical domains which played a crucial role in the development and implementation of the approach at hand. The increasingly growing field of research and practice linked to Climate Change Education (CCE) provides insights about enhancing the understanding of climate change and its consequences and preparing current and future generations to respond to its challenges by developing their competencies and increasing critical engagement, thus empowering individuals to deal with the complexity of it (Beatty, 2012). In addition to being aware of the disengaging impact of conveying "doom-and-gloom" messages about climate change, scientists argue for a politically and psychologically smart (Ockwell et al., 2009) creation of positive visions, however, respecting acknowledged success factors (Nisbet, 2009; O'Neill and Nicholson-Cole, 2009; Moser, 2010; Spence and Pidgeon, 2010; Wolf and Moser, 2011; Corner et al., 2014). In contrast to the longstanding misconception in Environmental Psychology research about educating the public about climate change to correct an "information deficit", it is one of the key insights of CCE that social norms and personal values, emotions and experiences are much more important than knowledge as such (Marx et al., 2007; Moser, 2010; Vulturius et al., 2016). Latest research from policy experts suggests that "knowing your audience", "setting clear, realistic goals", "not trying to scare people into action", "earning and maintaining trust", "recognizing the importance of values and social norms" and "not expecting to win every time" are key success factors of CCE.

In addition to CCE, transdisciplinary knowledge production offers a highly relevant theoretical field as a fundament for the development